PTO 2003-2194 DE 19,838,390

Translation of German Patent Document No. 19,838,390
Inventor: Peter Dietz et al.
Applicant: Siemens AG
Priority Date: N/A
Int. Class: G01 R 33/385
Application Date: August 24, 1998
Publication Date: March 2, 2000
Original German Title: Lärmreduziertes diagnostisches Magnetresonszgerät.

Translation

NOISE-REDUCING DIGNOSTIC MAGNETIC RESONANCE IMAGING DEVICE

The invention relates to a noise-reducing diagnostic magnetic resonance imaging device comprising a base field magnetic system, a gradient field magnetic system, and a support body including an antenna conductor structure, wherein the support body is independently supported by the gradient field magnetic system on the ground field magnetic system.

A diagnostic field magnetic resonance device utilizes a strong and homogenous magnetic field, which is generated by a base field magnetic system, in order to adjust the nuclear spin. The field strength of the base magnetic field is typically 1 to 1.5 T. A gradient field magnetic system generates increasing fields of approximately 25mT/m along the three spatial axes for the local resolution. The currents generating the gradient fields are

several 100 A strong. These gradient fields are switched on rapidly, and that means that the currents in the coil change rapidly. Given the physical fact that a force is exerted on the current conductor in a magnetic field, enormous forces are generated in the gradient field magnetic system. Constant changes in the current cause the gradient field magnetic system to oscillate. For a patient, who is placed in the direct vicinity of the gradient field magnetic system in order to be examined, it is necessary to limit the noise generated by the gradient field magnetic system to a tolerably level.

A diagnostic magnetic resonance system of the aforementioned type is described in German Patent document DE-OS 197 22 193. In addition to a base field magnetic system and a gradient field magnetic system, the document also describes an antenna conductor structure, which is configured as a support tube on a support body. The support body is supported independently of the gradient field magnetic system on the base field magnetic system. In this case, the space provided for the support body is utilized for construction in the region of the antenna conductor structure, with light, rugged, but as little material as possible being employed in order to keep the loss of quality of the high frequency antenna low. In one of the embodiments described there, the support tube is provided with hollow honeycomb annular layers of plastic extending radially on the longitudinal

axes of the honeycomb structure. The hollow spaces of the honeycombs may additionally be filled with sound absorbing material. The support tube of the antenna, which is mechanically completely disconnected from the gradient field magnetic system, has the advantage of preventing the direct transmission of body sound from the gradient field magnetic system. The sound is also absorbed owing to its internal honeycomb structure. Nevertheless, under certain operating conditions the patient is still exposed to a significant amount of noise.

It is therefore the object of the present invention to provide a diagnostic magnetic resonance device in which the noise generated by the gradient field magnetic system is further reduced.

The problem under consideration is solved in that the support body is part of a sound damping arrangement, with said sound damping arrangement being connected to the base field magnetic system which encapsulates the patient space from the gradient field magnetic system, and in that an intermediate space between the support body and the gradient field magnetic system is filled with a sound absorbing material. The inventive diagnostic magnetic resonance device is equipped to expose the patient to significantly less noise. In this case, the space required for the free interior space of the base field magnetic systems remains the same. The free diameter (warm

bore) of the base field magnetic system determines to a large extent the price of the base field magnet. The measures employed for reducing the noise merely require the space which is needed for the high frequency antenna system to operate properly in any case. The distance of the antenna conductor structure, on the other hand, should not be less than the minimum distance between a surrounding high frequency shield. The high-frequency shield is arranged on the support body for the gradient field magnetic system. On the other hand, the antenna conductor structure must remain at a minimum distance from the patient in order to prevent local field intensities in the tissue of the patient being examined. The noise reduction is a function of the additional measures. First, the gradient field magnetic system is sound insulated by a suitable construction of the high frequency support body. The term "insulation" in this case means that the noise generated by the sound source is insulated in a closed volume (sound insulation). The sound waves impacting the support tube inside the insulation are reflected and cannot exit through the support tube. Owing to the relatively small characteristic impendence of air, heavy, solid substances having high characteristic impedances are suitable for sound insulation. The support tube must therefore be as heavy as possible. The greater the mass, the smaller the oscillation amplitudes of the tubular wall become. A further

significant point is the level of the sound pressure in the intermediate space between the sound insulating arrangement and the gradient field magnetic system. The wider the air gap is configured, the lower the sound pressure level becomes. This is why the support tube must have the thinnest possible walls. Furthermore, due to the support of the support body in the base field magnetic system, no body sounds can be transmitted to the support body. Sound transmission is therefore based on the vibrations of the gradient field magnetic system through the activation of air vibrations in the intermediate space between the gradient field magnetic system and the support body. In this case, the vibrations are activated in the circumferential direction. In order to prevent this from occurring, the intermediate space is filled with a sound absorbing material. The volume weight of the sound absorbing material is low, and it has a slow dielectric loss factor in order to keep the adverse effect on the quality of the high frequency antenna system low. The sound absorbing material is porous and soft in order to have a sound-absorbing effect and to be able to absorb sound and simultaneously prevent body sound from being transmitted.

In an advantageous embodiment, the support body is made of glass-fiber reinforced plastic. This allows the requirements for a sufficiently low

loss factor and short post-oscillation time to be fulfilled owing to high mechanical damping and sufficient strength.

In a further advantageous embodiment, the sound insulating arrangement is provided with two terminating caps, each of which is configured as one piece, wherein each terminating cap is connected with one end of the support body and an adjacent end surface of the base field magnetic system, respectively. This minimizes any gaps through which noise could escape from the enclosure.

The outer component of the whole body scanner which, in this case, is configured as a diagnostic magnetic resonance device, comprises a base field magnetic system 2, which includes supra-conductive magnet coils arranged in a cryostat. The cryostat, including the magnetic coils, encloses a cylindrical interior space 4 in which the other components of the magnetic resonance device are arranged. First, a gradient field magnetic system 6 is arranged as hollow cylindrical component by means of a plurality of fasteners 8 on the wall of the interior space 4. A tubular support body 10, is arranged on the inside of the gradient field magnetic system 6, this body is fastened by means of brackets 12 to the inside wall of the base field magnetic system 2. In this case, the tubular support body 10 extends in the lower region into the bearing shells 14 in which a stretcher for the patent

(not illustrated) may be guided. On the inside of the tubular support body 10 is a patient space 13, which is configured to hold the patient being examined. The base field magnetic system 2, the gradient field magnetic system 6, and the support body 10 are connected coaxially to one another. The support body 10 is thin-walled and is preferably made of a very dense material.

The support body 10 is made of a glass fiber-reinforced plastic material. The glass fibers are wound as filament windings to cross at a relatively flat angle of less than 60° relative to the longitudinal axis of the support body 10. The wall thickness of the support body 10 is a function of the distance of the supports 12, and is approximately 1 cm.

Flat antenna conductor structures 15, the wide surfaces of which are rigidly connected to the support tube 10, are arranged on the outside of the support body 10. The antenna conductor structures 15 are not provided with further wide surface conductors in which strong eddy current could be generated. This prevents the antenna conductor structure 15 and, as a consequence, the support body 10 as well, from becoming a source of noise caused by Lorentz forces.

A free intermediate space 16 on the order of 3-4 cm in the radial direction is provided between the outer surface of the support body 10 and the inside surface of the gradient field magnetic system 6.

Compatibility requirements for the constructive configuration of the support body 10 and the intermediate space 16 are that the natural vibrations of the support body 10 do not overlap with those of the gradient field magnetic system 6 and the intermediate space 16 with respect to frequency. Identical natural frequencies would not permit the desired noise reduction within the indicated small distances of a few centimeters.

The intermediate space 16 is filled with a sound absorbing material 18. A PU-foam to which a melanin resin is added for fire protection, is especially suitable. The foam is porous and elastically soft, such that the filling can cling to the surfaces and, as a result, no larger air spaces remain after the assembly.

One-piece plastic bodies 22 are fastened to both end faces of the support body 10 and the base field magnetic system 2. These pieces encapsulate the gradient field magnetic system 6 and the support body 10 completely with respect to the sound. The plastic pieces 22 are configured in such a way that, compared with air, they have a very high characteristic impedance.

Since the support tube 10, together with the antenna conductor structures 15, and the sound-absorbing material 18, are inserted into the gradient field magnetic system 6, the sound-absorbent material 18 is

surrounded by an air tight sheet. The sheet forms a vacuum cushion, which is emptied prior to the assembly and thereby decrease the outer diameter of the component. After assembly, the sheet is opened, and the incoming air causes the sound-absorbing material 18 to expand and closely contact the surfaces and the remaining space of the intermediate space 16.

CLAIMS

1. A noise-reducing diagnostic magnetic resonance imaging device comprising a base field magnetic system (2), a gradient field magnetic system (6), and a support body (10) including an antenna conductor structure (15), wherein the support body (10) is independently supported by the gradient field magnetic system (6) on the ground field magnetic system (2), characterized in that the support body (10) is part of a sound damping arrangement, with said sound damping arrangement being connected to the base field magnetic system (2) which encapsulates the patient space from the gradient field magnetic system (6), and in that an intermediate space (16) between the support body (10) and the gradient field magnetic system (6) is filled with a sound absorbing material (18).

2. A noise-reducing magnetic resonance imaging device as defined in Claim 1, characterized in that the support body (10) is made of a glass fiber reinforced plastic.

3. A noise-reducing magnetic resonance imaging device as defined in Claims 1 or 2, characterized in that the support body (10), the gradient field magnetic system (6) and the base field magnetic system (2) are configured tubular and are arranged coaxially to one another, with the support body (10) being arranged on the inside, and the base field magnetic system (2) on the outside, and with the gradient field magnetic system (6) being arranged there-between.

4. A noise-reducing magnetic resonance imaging device as defined in Claim 3, characterized in that the sound absorbing arrangement comprises two terminating caps (22) terminating caps, each of which is configured as one piece, wherein each terminating cap (22) is connected with one end of the support body (10) and an adjacent end surface of the base field magnetic system (2), respectively.

5. A noise-reducing magnetic resonance imaging device as defined in Claims 1 to 4, characterized in that a porous, sound absorbing material (18) and an elastic, soft foam material fills the intermediate space (16).

6. A noise-reducing magnetic resonance imaging device as defined in Claims 3 to 5, characterized in that the antenna conductor structure (15) is arranged on the outside of the support body (10).

US Patent and Trademark Office
Translations Branch
Martha Witebsky - March 10, 2003

Nummer:	DE 198 38 390 A1
Int. Cl.7:	G 01 R 33/385
Offenlegungstag:	2. März 2000